FEASIBILITY STUDY OF THE
BENEFICIATION OF MAGNETITE
BEARING IRON ORE
FOR
BOREALIS EXPLORATION, LTD.
RR #80-233

ERIEZ
ERIE, PENNSYLVANIA

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HEADQUARTERS
DIVISION

August 20, 1980

Borealis Exploration Ltd.
Route 3, Box 399E
Hillsboro, Oregon 97123

Attention: Mr. Rodney Cox

SUBJECT: ERIEZ RR#80-233

Dear Rod:

In compliance with our phone conversation, please find enclosed our report RR#80-233 on the feasibility study of your iron ore beneficiation.

Our study so far shows that the upgrading to 62% Fe can be achieved, however pilot plant scale is now highly recommended with optimized operating parameters for weight and iron units recovery. The pilot tests will also generate data for scale up purposes which will be required to study the economics of an operating production plant.

We recommend piloting at the proposed mine site where various blends of drill core samples can be tested. For us to conduct these tests here at Eriez, special arrangements must be made by you to have a crusher and possibly a mill to be sent to us. Moreover, we will have to purchase certain material handling equipment to handle approximately six to ten tons of ore and we estimate testing charges to be approximately $2,000 per ton less analysis charges.

Please review this report and we will appreciate your comments. Our invoice for this feasibility test is attached.

Best wishes,

Richard B. Jacob
Manager
Ore Treatment Division
gmn
Encl.
cc: Greaves Company, Paul McDonald
cc: Eriez of Canada, Bob Gatt
cc: E.S. Twichell, Sales Manager
cc: A.E. Gedgaudas, Separation Division

cc: Borealis Exploration Ltd.
#308630 8th Ave. S.W.
Calgary, Alberta
T2P 1G8, Canada

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Eriez Manufacturing Co. Affiliates In: AUSTRALIA • BRAZIL • CANADA • JAPAN • MEXICO • SOUTH AFRICA • UNITED KINGDOM

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SUMMARY

Borealis Exploration, Limited has holdings which contain large reserves of magnetite. Since these are located above the Arctic Circle, it is imperative that a dry magnetic flowsheet be developed. Eriez has undertaken the feasibility study and achieved the desired results, as detailed in the following report.

Central Test Laboratory
REPORT OF TEST

Date: AUGUST 12, 1980 Research Request: #80-233

Test Made For: BOREALIS EXPLORATION, LIMITED

Address

City State

1.0 TITLE: Feasibility study of the beneficiation of magnetite bearing iron ore.

2.0 OBJECTIVE: Using dry magnetic separation to obtain a 62% Fe grade concentrate.

3.0 INTRODUCTION: This Research Request is a feasibility study to determine the magnetic separation flowsheet required to upgrade the iron ore. This ore body is found on the Melville Peninsula in the Northwest Territory of Canada.

It is the intent to process 2,000 TPH of crude ore, upgrading to a 62% Fe minimum in the concentrate. This facility is located above the Arctic Circle and a wet processing plant would be expensive and difficult to operate. Therefore, this study was completed with the consideration of dry processing only.

4.0 METHOD:

4.1 Sample Preparation - Approximately 100 pounds of sample was received for testing, packed in a burlap bag. It consisted mostly of pieces of ore between 4" and 1". Tests began with the ore as received, with no special preparation.

The jaw crusher used was a Sturtevant 2" X 6" Laboratory Jaw Crusher. A Morse 12" Gy-roll Crusher was used for all secondary crushing. When crushing to -200 mesh with the Gy-roll crusher, some oversize material remained. This was placed in a Denver 6" X 14" Laboratory Rod Mill until passing.

Riffle splitters were used for sampling of all test fractions.

4.2 Equipment Used - Eriez Electromagnetic Pulley Type (PT) Separator was used for cobbing. After the primary crushing, the High Speed Magnetic Drum Separator, Model DF, was used. Two magnetic pole configurations, the A-25 and A-50, were used for various tests on the DF Drum.

4.2 (cont'd.)

Operating parameters were chosen by running several tests and using reasonable judgement for optimum results. Since such a small sample was available for testing, feed rates could not be determined.

4.3 Test Procedures - Cobbing tests were completed with the ore as received. The PT Separator was run at a belt speed of 350 FPM, which is typical for this material. Several field intensities were tried by adjusting the current to the separator. Both magnetic and non-magnetic fractions were produced. When a significant difference existed between the fractions, it was assummed that parameters had been optimized. The final power setting was at 51% of hot current ratings.

The PT Separator produced two fractions for primary crushing to approximately 1". After crushing, a screen analysis was performed and is listed in the Appendix.

The non-magnetics and the magnetics from the PT Separator were then processed through identical flowsheets. These flowsheets will be referred to as the non-magnetic side and the magnetic side with respect to the non-magnetics and magnetics from the PT Separator.

After primary crushing, the entire sample was screened at 1/4". The oversize material was given an additional pass over the PT Separator. No split could be made with the material from the non-magnetics side. The magnetics side produced a split which, after careful evaluation, was re-combined.

The -1/4" material was taken and given a single pass over the DFA-25 operating at a surface speed of 750 FPM.

The oversize was then taken to the Gy-roll Crusher and reduced to 100% -4 mesh. A screen analysis was prepared and is listed in the Appendix. This material was then taken to the DFA-25. Surface speed in this test was 750 FPM. Two fractions were produced with the magnetics taken for further processing.

The magnetics were subjected to a first stage fine crushing using the Gy-roll Crusher to 35 mesh. The first stage crushing fines were then subjected to another DFA-25 at 750 FPM surface speed. Screen analysis of both the non-magnetic and magnetic fractions are listed in the Appendix.

The magnetics obtained were taken to secondary fines crushing for reduction to -200 mesh using the Gy-roll Crusher. Some coarse material remained, which was taken to the Rod Mill for final reduction.

The final stage magnetic separation was made using the DFA-50 at 1,250 FPM surface speed. An initial test revealed much carry-over of dust into the magnetic concentrate. To reduce this problem, a dust collector vacuum line was installed to remove as much dust as possible. It is necessary to install the extended splitter at about the eight o'clock position for separation.

4.4 Assays - All samples obtained were labeled with a number corresponding to their location on the flowsheet. Samples for analysis were obtained using standard sampling procedures with a riffle splitter.

Chemical analysis was performed by an independant laboratory, Erie Testing Laboratories. An acid digestion procedure was used for all samples. Additionally, a fusion technique was applied to the final magnetic concentrates, which revealed higher iron contents.

Metallurgical balance sheets are included to illustrate the results at each stage and for overall systems. Some inaccuracies exist in the balances due to the size of the original sample and the dust collector used for the final stage.

Davis Tube magnetics were completed on some of the fractions of the DF Drum after the primary fine crushing stage. The 100 X 200, 200 X 325 and -325 mesh fractions of the magnetics from both sides of the flowsheet were tested. Iron assays were then made of the Davis Tube magnetics.

Sink-float analysis was made of the final magnetic fractions. A tetrabomoethane liquid, having a specific gravity of 2.9, was used in separating flasks. Photomicrographic analysis was made of the float fraction. The Polaroid photographs will be kept on file.

5.0 TEST RESULTS: A grade of 63.7% Fe (acid soluble) was obtained on the magnetics side. The fusion technique showed an increase in grade to 64.4% Fe.

The final magnetic concentrate obtained on the non-magnetic side of the flowsheet assayed 56.1% acid soluble iron. The fusion assay procedure greatly increased the grade to 65.1% Fe.

Overall recovery for the system at a grade of 58.6% Fe is 74.4%. This is reported as acid soluble iron. It is assummed that a fusion assay procedure would report a minimum of 62% Fe grade.

6.0 EVALUATION: If the total iron as reported by the fusion assay technique is considered, magnetic separation exceeded the minimum grade requirement.

Recovery of the system can be reasonably expected to be 85% to 90% of the available iron.

It is necessary to mill this ore to -200 mesh to obtain a grade of 62% Fe.

Three stages of magnetic separation and crushing will produce the best results with a minimum of crushing.

The PT Separator produced two fractions that do not appear different at the first stages. Both sides of the flowsheet showed similar screen analyses after crushing and milling. The similarities end at the final concentrates. Acid soluble iron from the non-magnetics side was 56.1% Fe and from the magnetics side, 63.7%. The fusion assay procedure showed nearly the same iron values for both concentrates. This indicated a problem with liberation. Microscopic examination of the floats

6.0 (cont'd.)

from the heavy liquid analysis confirmed this. The magnetics side concentrate floats showed very good liberation. The non-magnetics side concentrate floats showed considerable iron trapped inside silica, where only a fusion procedure would assay it.

The PT Separator is capable of removing all the ore received for testing as magnetics. It can also differentiate between high and low grade material contained in the ore.

The use of the vacuum dust collector on the DF Drum is necessary to produce the highest grade concentrate and eliminate dust carry-over.

7.0 EQUIPMENT RECOMMENDATIONS: Since this ore was a bad case example of the magnetite deposit, a pilot plant is recommended. The pilot plant should test the variations of the ore deposit to determine concentrates obtainable and the flowsheets required.

Equipment recommended for a pilot plant would be a 30" diameter X 24" wide Electromagnetic Pulley Type (PT) Separator with a Vibratory Feeder for the cobbing process.

For high speed magnetic drum separation, a unit as found in Eriez' Central Test Laboratory is suggested, incorporating several agitating fields. Alternatively, several 6" or 12" wide units could be used. Vibratory feeders are recommended to enable accurate feed rates to the separators to be maintained. The High Speed DF Drums should be equipped with variable speed drives, adjustable splitters and a vacuum arrangement on the non-magnetic discharge side.

Consideration must be given to the permanent magnet design for stability at low temperatures. The mean monthly winter temperature for this region is -20° F, with periodic lows considerably below this.

8.0 CONCLUSIONS: A concentrate of +62% Fe can be made using a totally dry magnetic separation flowsheet.

The PT Separator can classify between high and low grade magnetite ores.

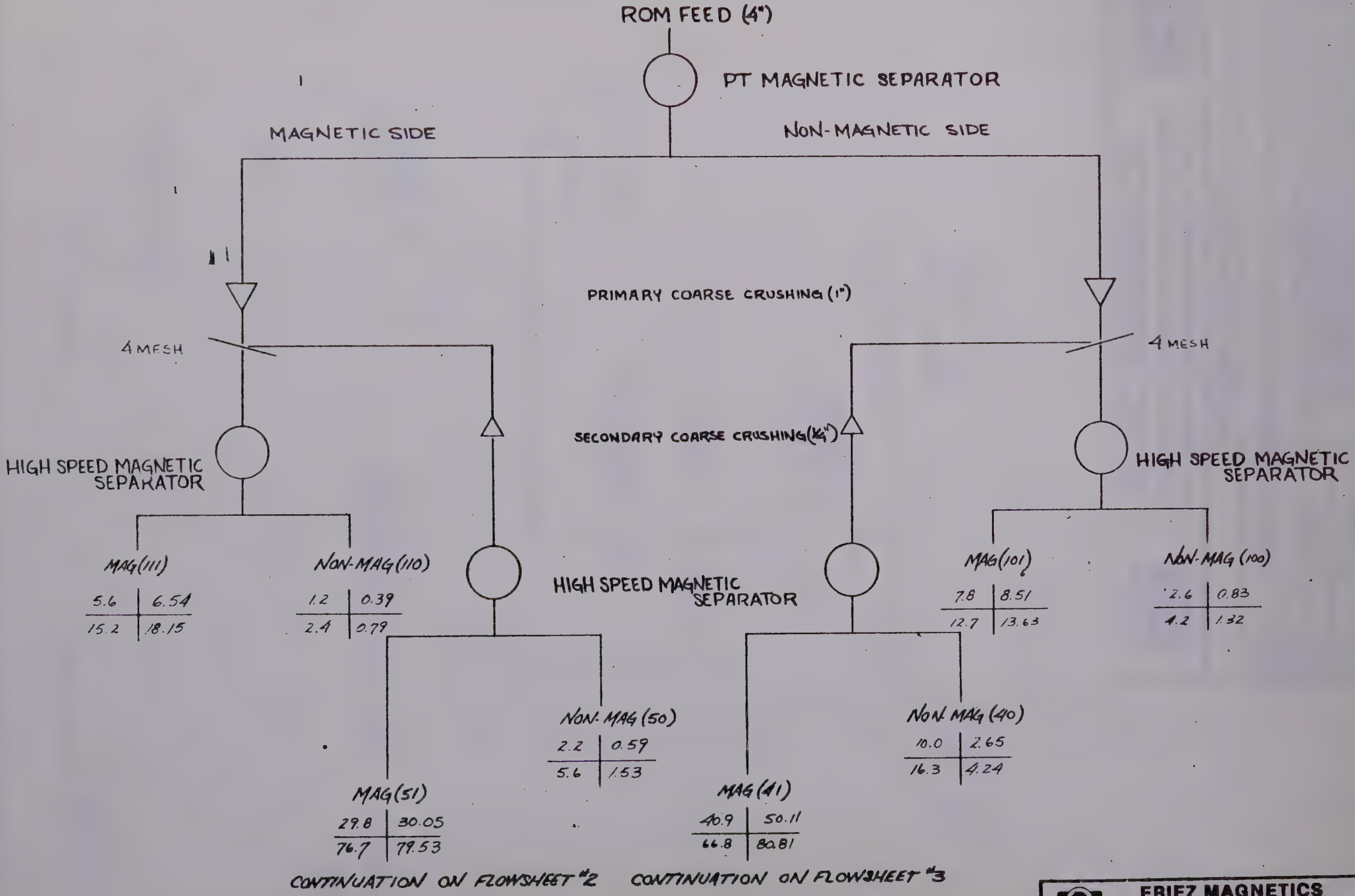
Several stages of grinding and magnetic separation will produce the highest grade with the least milling costs due to non-magnetics removal at each stage.

Michael J. Ross

Michael Ross
Mineral Processing Engineer

MR/rh

COARSE COBBING TESTS



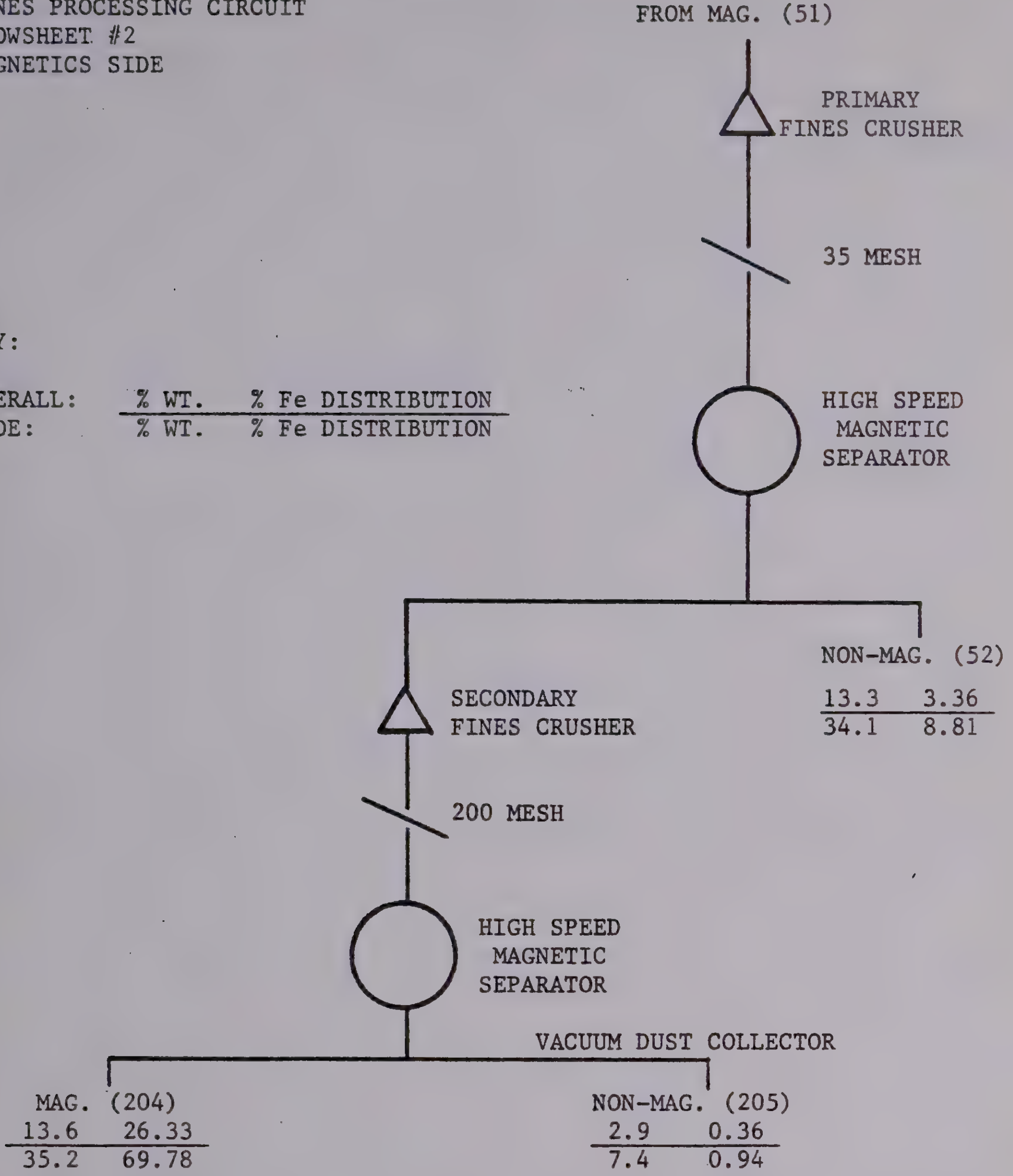
KEY		
OVERALL	% WT	% Fe DISTRIBUTION
SIDE	% WT	% Fe DISTRIBUTION

ERIEZ MAGNETICS
WORLD AUTHORITY IN MAGNETIC AND VIBRATORY EQUIPMENT
ERIEZ HEADQUARTERS DIVISION, ERIE, PA., U.S.A.
PROCESS FLOWSHEET
BOREALIS EXPLORATION LIMITED
[illegible]

FINES PROCESSING CIRCUIT
FLOWSHEET #2
MAGNETICS SIDE

KEY:

OVERALL:	% WT.	% Fe DISTRIBUTION
SIDE:	% WT.	% Fe DISTRIBUTION



ERIEZ MAGNETICS

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ERIE HEADQUARTERS DIVISION, ERIE, PA., U.S.A.

PROCESS FLOWSHEET

FOR: BOREALIS EXPLORATION, LTD.

DWG. BY:

DATE: 8/12/80

R R# #80-233

FIG# 2 PAGE -7-

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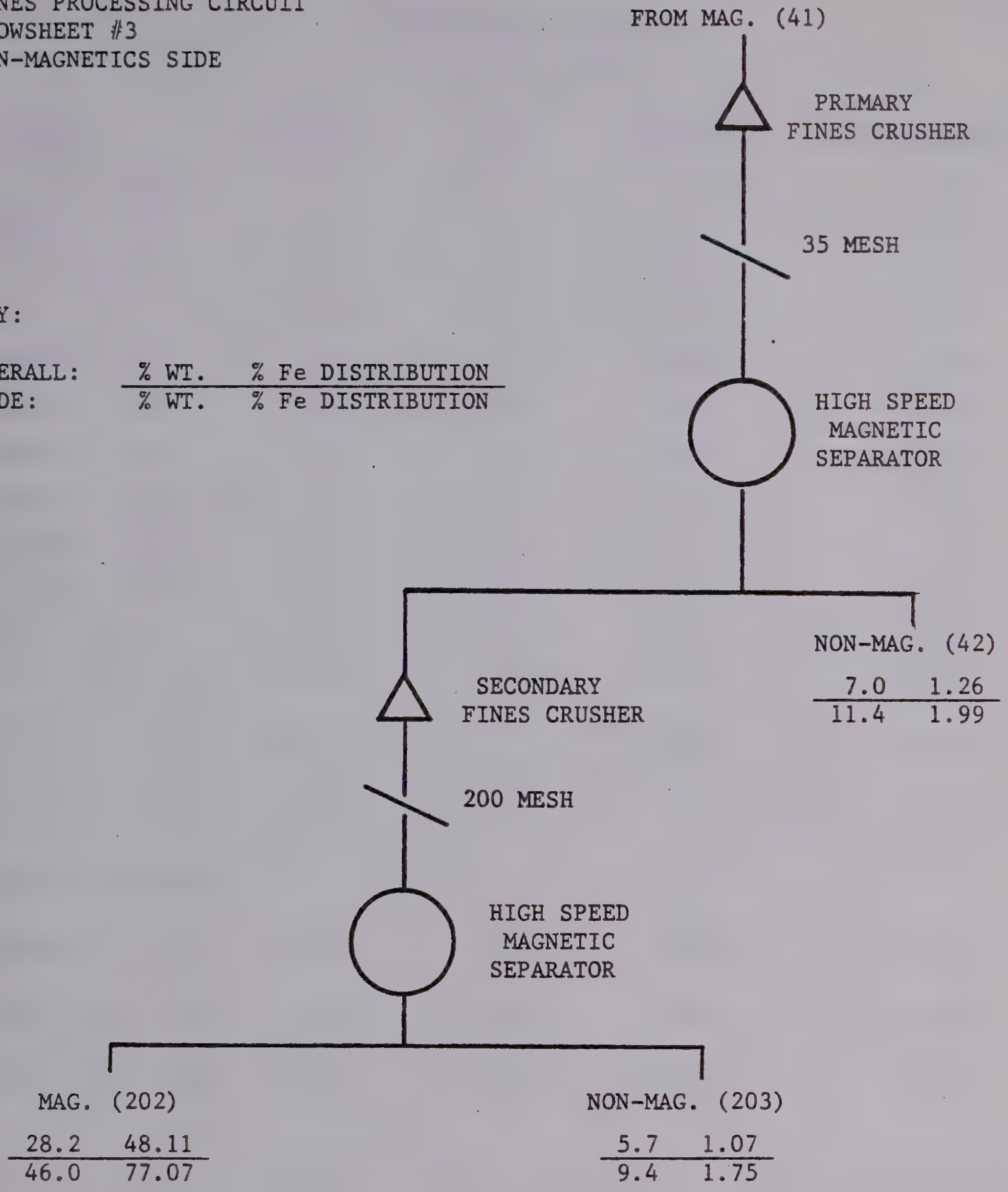
FINES PROCESSING CIRCUIT
FLOWSHEET #3
NON-MAGNETICS SIDE

KEY:

OVERALL:	% WT. % Fe DISTRIBUTION
SIDE:	% WT. % Fe DISTRIBUTION



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WORLD AUTHORITY IN MAGNETIC AND VIBRATORY EQUIPMENT
ERIE HEADQUARTERS DIVISION, ERIE, PA., U.S.A.

PROCESS FLOWSHEET

FOR: BOREALIS EXPLORATION, LTD.
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FIG# 3 PAGE -8-

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BOREALIS EXPLORATION, LTD.
RR #80-233
FIGURE #4

METALLURGICAL BALANCE

OVERALL FLOWSHEET

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
NON-MAG. (100)	2.6	10.5	0.273	0.83
NON-MAG. (110)	1.2	10.6	0.127	0.39
MAG. (101)	7.8	35.9	2.800	8.51
MAG. (111)	5.6	38.4	2.150	6.54
NON-MAG. (40)	10.0	8.7	0.870	2.65
NON-MAG. (50)	2.2	8.8	0.194	0.59
NON-MAG. (42)	7.0	5.9	0.413	1.26
NON-MAG. (52)	13.3	8.3	1.104	3.36
NON-MAG. (203)	5.7	6.2	0.353	1.07
NON-MAG. (205)	2.9	4.1	0.119	0.36
MAG. (202)	28.2	56.1	15.820	48.11
MAG. (204)	13.6	63.7	8.663	26.33
	100.0		32.886	100.00

COMBINED PRODUCTS:

NON-MAG.	44.9	7.7	3.453	13.963
MAG. (101 + 111)	13.4	36.9	4.950	15.050
MAG. (202 + 204)	41.8	58.57	24.483	74.44

BOREALIS EXPLORATION, LTD.
RR #80-233
FIGURE #5

METALLURGICAL BALANCE

NON-MAGNETICS SIDE

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
NON-MAG. (100)	4.2	10.5	0.441	1.32
MAG. (101)	12.7	35.9	4.559	13.63
NON-MAG. (40)	16.3	8.7	1.418	4.24
NON-MAG. (42)	11.4	5.9	0.668	1.99
NON-MAG. (203)	9.4	6.2	0.584	1.75
MAG. (202)	46.0	56.1	25.788	77.07
	100.0		33.458	100.00

MAGNETICS SIDE

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
NON-MAG. (110)	2.4	10.6	0.254	0.79
MAG. (111)	15.2	38.4	5.832	18.15
NON-MAG. (50)	5.6	8.8	0.493	1.53
NON-MAG. (52)	34.1	8.3	2.830	8.81
NON-MAG. (205)	7.4	4.1	0.303	0.94
MAG. (204)	35.2	63.7	22.422	69.78
	100.0		32.134	100.00

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RR #80-233
FIGURE #6

METALLURGICAL BALANCE

NON-MAGNETICS SIDE

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
SECONDARY FINES PROCESSING:				
MAG. (202)	83.0	56.06	46.530	97.78
NON-MAG. (203)	17.0	6.21	1.056	2.22
CALC. HEAD (43)	100.0		47.586	100.00
PRIMARY FINES PROCESSING:				
MAG. (43)	82.9	47.60	39.460	97.52
NON-MAG. (42)	17.1	5.86	1.002	2.48
CALC. HEAD (41)	100.0		40.462	100.00
SECONDARY COARSE PROCESSING:				
MAG. (41)	80.4	40.5	32.558	95.02
NON-MAG. (40)	19.6	8.7	1.706	4.98
CALC. HEAD	100.0		34.264	100.00
PRIMARY CRUSHER FINES (-1/4") PROCESSING:				
MAG. (101)	75.2	35.9	26.997	91.20
NON-MAG. (100)	24.8	10.5	2.604	8.80
CALC. HEAD	100.0		29.601	100.00
NON-MAGNETICS SIDE OF PT SEPARATOR:				
(100 + 101)	16.9	29.6	5.002	14.93
(41 + 40)	83.1	34.3	28.503	85.07
CALC. HEAD (1)	100.0		33.505	100.00

BOREALIS EXPLORATION, LTD.
RR #80-233
FIGURE #7

METALLURGICAL BALANCE

MAGNETICS SIDE

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
SECONDARY FINES PROCESSING:				
MAG. (204)	82.6	63.7	52.616	98.66
NON-MAG. (205)	17.4	4.1	0.713	1.34
CALC. HEAD (51)	100.0		53.329	100.00
PRIMARY FINES PROCESSING:				
MAG. (53)	55.5	53.3	29.582	88.90
NON-MAG. (52)	44.5	8.3	3.694	11.10
CALC. HEAD (51)	100.0		33.276	100.00
SECONDARY COARSE PROCESSING:				
MAG. (51)	93.2	32.2	30.010	98.05
NON-MAG. (50)	6.8	8.8	0.598	1.95
CALC. HEAD	100.0		30.608	100.00
PRIMARY CRUSHER FINES (-1/4") PROCESSING:				
MAG. (111)	86.4	38.37	33.152	95.84
NON-MAG. (110)	13.6	10.58	1.439	4.16
CALC. HEAD	100.0		34.591	100.00
MAGNETICS SIDE OF PT SEPARATOR:				
(111 + 110)	17.6	34.6	6.090	19.45
(51 + 50)	82.4	30.6	25.214	80.55
CALC. HEAD (2)	100.0		31.304	100.00

APPENDIX

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SCREEN ANALYSIS OF PRODUCT FROM PRIMARY JAW CRUSHER

% WEIGHTS

	NON-MAG. (1)	MAG. (2)
1-1/2"	1.6%	2.6%
1-1/2" X 1"	8.8%	10.9%
1" X 3/4"	14.4%	15.9%
3/4" X 1/2"	29.3%	28.0%
1/2" X 3/8"	13.0%	10.8%
3/8" X 1/4"	12.0%	10.9%
1/4" X 10 m	12.6%	12.3%
-10 m	8.3%	8.6%
	100.0%	100.0%

SCREEN ANALYSIS OF SECONDARY COARSE CRUSHER

NON-MAG. (1)*

SCREEN	% WT.
4 MESH	13.5
4 X 10 MESH	48.9
10 X 28 MESH	16.5
28 X 48 MESH	3.7
48 X 100 MESH	2.4
-100 MESH	15.0
	100.0

* - LESS -1/4" MATERIAL BEFORE CRUSHING

APPENDIX (3)

METALLURGICAL BALANCE

NON-MAGNETICS SIDE OF FLOWSHEET

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
SCREEN ANALYSIS OF NON-MAGNETICS (42):				
+28 (60)	2.96	6.79	0.2010	3.43
28 X 48 (61)	7.30	7.00	0.5110	8.72
48 X 100 (62)	9.00	5.58	0.5022	8.57
100 X 200 (63)	28.50	4.42	1.2597	21.49
200 X 325 (64)	27.06	5.35	1.4477	24.70
-325 (65)	25.18	7.70	1.9389	33.09
CALC. HEAD (42)	100.00		5.8605	100.00
SCREEN ANALYSIS OF MAGNETICS (43):				
+28 (66)	12.74	36.12	4.6017	11.16
28 X 48 (67)	18.03	36.51	6.5828	15.97
48 X 100 (68)	12.81	37.38	4.7884	11.62
100 X 200 (69)	20.88	41.85	8.7383	21.20
200 X 325 (70)	26.72	42.35	11.3159	27.45
-325 (71)	8.82	58.84	5.1897	12.60
CALC. HEAD (43)	100.00		41.2168	100.00

APPENDIX (4)

DAVIS TUBE MAGNETIC TEST:

FRACTION	% D.T. MAG.	% MAG. Fe
(69)	93.61	43.41
(70)	88.87	57.16
(71)	84.08	61.70

APPENDIX (5)

METALLURGICAL BALANCE

MAGNETICS SIDE OF FLOWSHEET

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
SCREEN ANALYSIS OF NON-MAGNETICS (52):				
+28 (80)	1.76	16.45	0.2895	3.49
28 X 48 (81)	5.11	14.64	0.7481	9.02
48 X 100 (82)	6.51	10.65	0.6933	8.36
100 X 200 (83)	15.83	6.07	1.5679	18.91
200 X 325 (84)	39.17	7.11	2.7850	33.60
-325 (85)	21.62	10.21	2.2074	26.63
CALC. HEAD (52)	100.00		8.2912	100.00
SCREEN ANALYSIS OF MAGNETICS (53):				
+28 (86)	9.33	36.71	3.4250	7.68
28 X 48 (87)	16.38	37.54	6.1491	13.79
48 X 100 (88)	11.88	37.21	4.4205	9.91
100 X 200 (89)	20.81	44.17	9.1918	20.61
200 X 325 (90)	34.72	52.05	18.0718	40.53
-325 (91)	6.88	48.48	3.3354	7.48
CALC. HEAD	100.00		44.5936	100.00

APPENDIX (6)

DAVIS TUBE MAGNETICS TEST:

FRACTION	% D.T. MAG.	% MAG. Fe
(89)	91.81	46.61
(90)	83.42	60.57
(91)	72.67	62.17

APPENDIX (7)

RESULTS OF HEAVY LIQUID ANALYSIS

MAGNETICS (202)	9.3% FLOAT
MAGNETICS (204)	4.4% FLOAT

FLOAT PRODUCT IS < 2.9 sp.gr.

APPENDIX (8)

METALLURGICAL BALANCE

NON-MAGNETICS SIDE OF FLOWSHEET

SECONDARY FINES PROCESSING WITHOUT VACUUM DUST COLLECTOR:

FRACTION	% WT.	% Fe	Fe UNITS	Fe % DISTRIBUTION
MAG. (200)	83.9	55.21	46.321	97.34
NON-MAG. (201)	16.1	7.86	1.265	2.66
CALC. HEAD (93)	100.0		47.586	100.00

Date Due

49451 Pam: 669.1
ERI

Eriez Magnetics.

AUTHOR Feasibility study of the beneficiation of magnetite
TITLE bearing iron ore for Borealis Exploration, Ltd.

DATE LOANED	BORROWER'S NAME	DATE DUE

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